LECTURE NOTES

For Environmental Health Students

Occupational Health, Safety, and Hygiene

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Preface

The discipline of occupational health is concerned with the two-way relationship between work environment and health. Occupational health is a part of the health science curriculum.

The philosophy aims to promote and maintain the highest degree of physical, mental and social well-being of workers in all occupations: to prevent departures from health caused by their working conditions; the protection of workers in their employment from risk resulting from factors adverse to health; the placing and maintenance of the workers in an occupational environment adapted to his physiological and psychological make-up.

This teaching material is prepared based on our own teaching experience and on curriculum of occupational health and safety for Ethiopia. There are five chapters in the lecture note, each of which has questions and exercises at the end.

Therefore, the material is designed to provide a clear and concise account of the principles and practices of occupational health safety and hygiene, and it is primarily suitable for students following diploma in environmental health sciences.

Acknowledgments

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Contents

Figures and Tables

CHAPTER ONE

Occupational Health Safety and Hygiene

1. Learning objectives

At the end of this chapter, the student will be able to:

1. Define occupational health
2. Explain workers' role in occupational health safety and hygiene service Programs
3. Discuss the scope of occupational health and safety.
4. Identify the elements of a work environment.
5. Discuss the three common interactions in the work place.
6. Explain how work affect health and health affects work.

2. Introduction

Occupational health is concerned with the control of occupational health hazards that arise as a result of or during work activities.

Occupational health or industrial hygiene has been defined as that "science and art devoted to the anticipation, recognition, evaluation and control of those environmental factors or stresses arising in or from the work place, which may cause sickness, impaired health and well-being, or significant discomfort among workers or among the citizens of the community". It encompass the study of chronic as well as acute conditions emanating from hazards posed by physical agents, chemical agents, biological agents and stress in the occupational environment and the outdoors environment.

Evaluation of the magnitude of the environmental factors and stresses arising in or from the work place is performed by the industrial hygienist, aided by training, experience and quantitative measurement of the chemical, physical, ergonomic, or biological stresses. He can thus give an expert opinion as to the degree of risk posed by the environmental factor or job stresses.

Occupational health or industrial hygiene includes the development of corrective measures in order to control health hazards by either reducing or eliminating exposures.

In this text therefore, industrial hygienist or occupational health worker is used interchangeably although the level of qualification and responsibility in some aspect differs. The objective in any case for both qualification is the protection of the worker from adverse health impairment and ill health.

Scope of occupational health safety and hygiene

The scope of occupational health safety and hygiene includes prevention and control of hazards, curative and rehabilitative programs.

These are: -

1. Establishment of sound sanitary condition within the work place such as Water supply, waste disposal, canteen, cloak room, shower and hand washing facilities, sanitary and safe storage of chemicals.
2. Organization of health services including first aid
3. Health promotion in the work environment
4. Rehabilitation of those that have been injured
5. Prevention, diagnosis, and treatment of occupational related diseases and accidents

The purposes of industrial hygiene program

1. To determine whether the work environment and working conditions of workers are harmful to their health and well-being and prevent such conditions from occurring.
2. To promote the best possible physical, mental and social health of people at work.
3. To prevent occupational diseases caused by physical chemical and biological agents.

The primary responsibility of the industrial hygienist is as follows:

1. To protect the health of the employees.
2. To maintain an objective attitude towards anticipation, recognition, evaluation and control of health hazards.
3. To council employees regarding the health hazards and the necessary precaution to avoid adverse health effects.
4. To respect confidences, advise honestly, and report findings and recommendations accurately.
5. To act responsibly in the application of industrial hygiene principles toward the attainment of a healthful working environment.

3. Historical incidents

The history of industrial hygiene can be traced back to the time of Hippocrates, who in the fourth century recognized and recorded the problem of lead toxicity in the mining industry. Other incidents include:

1. About 500 years after Hipocrates, the Greek physician Galen wrote at length on occupational diseases and recognized the dangers of acid mists to copper miners.
2. Other reports during the subsequent centauries described mining accidents and offered suggestions for mine ventilation and protective masks for miners, and discussed silicosis, a lung disease caused by inhaling silica dust.
3. During the 18th and 19th centuries industrial hygiene become of increasing importance and the period saw the publication of numerous works on the subject, as well as the passage in both England and Europe of the first effective legislation designed to protect the health of workers.
4. Occupational Safety and Health Administration (OSHA) of USA estimates that each year in the United States about 100,000

5. people die from occupational illnesses and in 1990 alone there were about 1.8 million disabling injuries on the job.
6. World wide there were an average of are 33 million occupational injuries per year with about 145,000 deaths. Such conditions may not get better as employment in firms and industries is increasing from year to year.
6. According to the Bureau of labor statistics in US, Over 280,000 occupational illnesses were identified recognized or diagnosed in 1989.
7. Among job related mortality figures, one study among workers in US from 1980 to 1989 found that motor vehicle accidents, machine injuries and homicide were the top three causes of work related deaths. From the 63, 589 on job deaths during the period, there were 14, 625 motor vehicle related deaths, 8903 happened from machine injury and 7,603 homicides were recorded.

Table 1. Accident rate collected from Industries in Addis Ababa, Dire Dawa and Asseb Port in 19 85 EC.

Sr. No.	Industry	Year	Accident rate
1	5 mills – Addis Ababa	1985 E.C.	294/1000/yr
2	11 urban factories Addis Ababa	1985 E.C.	80/1000/yr
3	Asseb Port	1985 E.C.	265/1000/yr - Machinery 20.05% - Collision 19.4% - Hit by flying fragments14.17%
4	Addis Ababa Textile	1985 E.C.	Machinery: 18.02%; hand tools: 11.88%; Collisi

4. Elements of the work environment

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

4.1 The worker
4.2 The tool
4.3 The process
4.4 The work environment

4.1 The worker

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

1. Most people who are employed 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 or not 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 Ethiopia is about $ 120 (U.S) or less per year which makes it one of the lowest in the world. Daily wage for all Ethiopian daily laborers is less than $1 US dollar.
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, the industrial hygienist will start his activities in sorting all those aspects of hazards including the worker himself.

4.2 The Tool

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

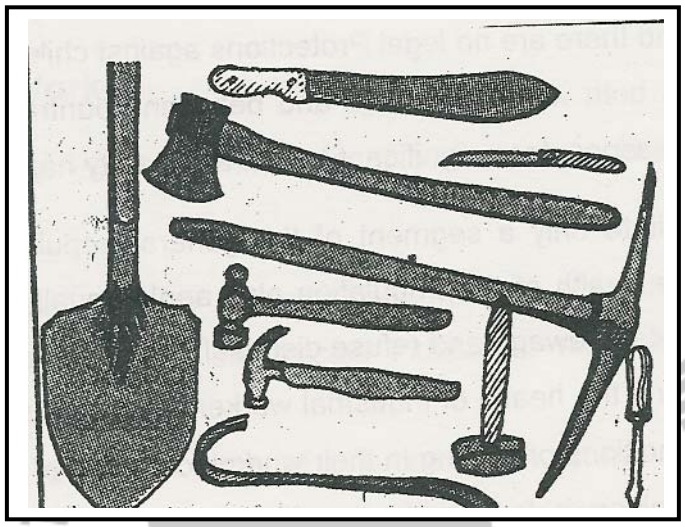

Fig.1. Simple hand tools are the causes of many accidents.

Source: Deglaville etal. Occupational Health, a manual for health workers in developing countries

4.3 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.

4.4 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 man 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
2. Man and machine
3. Man and his psychosocial environment

1. Man and physical, chemical and biological agents.

a. The physical agents

- Levels of noise
- Levels of heat and humidity
- Levels of dust
- Vibration
- Electricity or lighting
- Radiation etc.

b. Chemical agents

- Chemical dust
- Mists
- Fumes
- Liquids
- Vapors

C. The biological agents

- Presence of insects and rodents
- Microorganisms
- Poisonous plants and animals

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.

4. Questions and exercise

1. Define the following terms:
   a. Anticipation
   b. Recognition
   c. Evaluation
   d. Control
2. Why is occupational hygiene considered as one part of preventive medicine?
3. What are the three types of interaction in the working environment?
4. How can work affect health and health affect work? Give practical examples
5. Mention what you consider are the main roles of a sanitarian in Occupational health, safety and hygiene programs

Note to the teacher

Please take your students to an occupational setting (workshops, hospitals, classrooms, laboratories etc) and ask your students to indicate safety hazards in the work environment. Discuss their findings and your observation with the students. The assignment in the setting could be in teams. If so, ask the group leaders to present their findings to a plenary in the classrooms. This is one way of introducing participatory learning to your students.

CHAPTER TWO

Recognition of occupational health safety and hygiene hazards

1. Learning Objectives

At the end of this chapter, the student will be able to:

1. Identify the occupational health safety and hygiene hazards in workplace
2. Explain the effects of chemicals such as organic solvents.
3. Discuss the difference between ionizing and non-Ionizing radiations.
4. Mention the two main effects of noise.
5. Describe the occupational exposure to biohazards.
6. Give examples of some ergonomic hazards

2. Introduction

Occupational hazards include all those work activities and processes involving the worker, raw materials, and processing activities such as operating machineries and handling chemicals.

Workers whether they are farmers, students, secretaries, teachers, industrial workers or soldiers are exposed to some sort of hazards that may result from the nature of their day to day occupation.

The identification of occupational health safety and hygiene hazards has often come from observations of adverse health effect among workers. Unquestionably it is in the workplace that the impact of industrial exposures is best understood.

Identification of health and safety problems includes the following:

- Observe workplace
- Investigate complaints from workers

- Examine accident and near-miss records
- Examine sickness figures
- Use simple surveys to ask your co-workers about their health and safety concerns;
- Use check-lists to help you inspect your workplace;
- Learn the results of inspections that are done by the employer, the union or anyone else;
- Read reports or other information about your workplace

3. Classifications of occupational health, safety and hygiene hazards

The various hazards which gives rise to occupational diseases or adversely affect health through work may be classified as: -

3.1 Physical Hazards
3.2 Mechanical Hazards
3.3 Chemical Hazards
3.4 Biological Hazards
3.5 Ergonomic Hazards
3.6 Psychosocial Hazards

3.1 Physical 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.

Physical hazard include:

a. Extremes of temperature
b. Ionizing radiation
c. Non ionizing radiation
d. Excessive noise

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 includes soap factories in large industries and in the informal sectors who use extreme heat to mold iron or process other materials.

Effect of hot temperature in work place include:

1. Heat Stress

Heat stress is a common problem 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 degree Celsius below or 3 degree Celsius above the normal core temperature of 37.6 degree Celsius 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

b. Ionizing Radiation

Radiation is a form of energy. Any electromagnetic or particulate radiation capable of producing ions is referred to as ionizing radiation. Radioactive materials emit energy that can damage living tissues.

Different kinds of radioactivity presenting different kinds of radiation safety problems.

The types of ionizing radiation with which we will be concerned are:

<u>Electromagnetic</u>

- X-ray
- Gamma ray

<u>Particles</u>

- Neutron, electron, protons
- Alpha radiation
- Beta-rays

Radioactive materials can be hazardous in two ways:

1. Those materials that could be hazardous even when they are located some distance away from the body (external)
2. Others that are hazardous only when they get inside the body by through breathing, eating or through broken skin (internal)

C. Non-Ionizing Radiation

This is a form of It is electromagnetic radiation with varying effects on the exposed body depending largely on the particular wavelength of the radiation involved.

It includes:-

- Radio transmitters
- TV
- Power line
- Powerful radio aerials
- Microwaves
- Lasers etc

d. Excessive 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.

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.

Effects of Noise exposure

Noise is a health hazard in many in many occupational settings. Effects of noise on humans can be classified in 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 los involves damage to the structure of the hearing organ.

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 0r 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 type Noise: is a sharp burst of sound. A sophisticated instrumentation is necessary to determine the peak levels for this type of noise.

The effects of noise on humans can be classified into two types:

- Auditory effect
- Non auditory effect

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.

Non-auditory effects

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

3.2 Mechanical Hazards

The mechanical hazards in industries are contributed from machinery, protruding and moving parts. About 10% of accidents in industry are said to be due to mechanical causes.

Examples of vibrating and rotating tools are those used in drilling holes to burry dynamite in road construction and grinding metals. These activities can cause vibration disorders such as " dead hand" which is usually temporary and seldom leads to permanent damage. In industries repetitive movements of the hands and forearms are common, the tendon sheaths and musculo-cutaneous junctions become inflamed.

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.

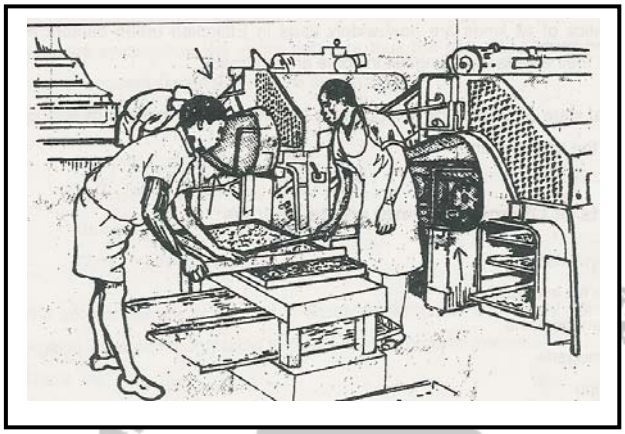

Fig.2. Moving part of machinery is securely fenced

Source: Deglaville etal. Occupational Health, a manual for health workers in developing countries

3.3 Chemical Hazards

There is hardly any industry, which does not make use of chemicals. The chemical hazards are on increase with the introduction of newer and complex chemicals.

Chemical hazards form the most important group and comprise over 12000 toxic materials. Such materials may endanger life, affect health adversely, or cause severe discomfort due to their acute effect. Moreover, they may produce long-term disease such as cancer and pneumoconiosis by their chronic effects.

Naturally occurring materials such as lead and mercury have been recognized as source of occupational disease for hundreds of years. With rapid industrial development other minerals like asbestos, radioactive ores, and oil, which are also sources of occupational

disease, have been taken from the earth. Growing range of man-made materials such as plastics, synthetic fibers, solvents, fertilizers, and pharmaceutical products all of which may be hazardous to those who make or use them. Plastics of all kinds are now widely used in Ethiopian urban centers and rural communities or villages and their effects are being felt in some areas already.

The physical state of a chemical compound is important in determining its toxicity to man and the environment.

The effects of chemical agents are as follows:

1. Asphyxiation
2. Systemic intoxication
3. Pneumoconiosis
4. Carcinogens
5. Irritation

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

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 through out 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 system includes those based in water.

Example:

- Aqueous solution of acids
- Aqueous solution of alkalis
- Aqueous solution of detergents

Aqueous system has low vapor pressure thus the potential hazard by

inhalation and subsequent systemic toxicity is not great.

Examples of non-aqueous systems

- 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

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 are exposed.
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.

Health and safety procedures

Occupational health professionals should be concerned with health and safety in recognizing that the use of solvent can be a major threat. It is also important that control measures and safety precaution be exercised.

1. Surveys should be made for evidence of disease
    - Dermatitis
    - Unusual behavior

- Coughing
- Complaints of irritation
- Headache - etc.

2. You should note conditions and practices that contribute to excessive exposure.
3. Design safety and control methods.

Fig.3. Pesticides are dangerous wherever used.

Source: Deglaville etal. Occupational Health, a manual for health workers in developing countries

Dangerous chemical substances

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

The classification of dangerous substances is based largely on the characteristic properties of such substances and their effects on man. Legislation 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 tissue as well as equipment are destroyed on contact with this 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. No open cigarette fire allowed 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 a void contact with skin and eye

F. Highly Flammable

Hazard: Substances with flash point less than 600c or 1400F.

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Caution: keep away source of ignition.

G. Explosive

Hazard: Substances which may explode under certain condition

Caution: Avoid shock, friction, sparks and heat.

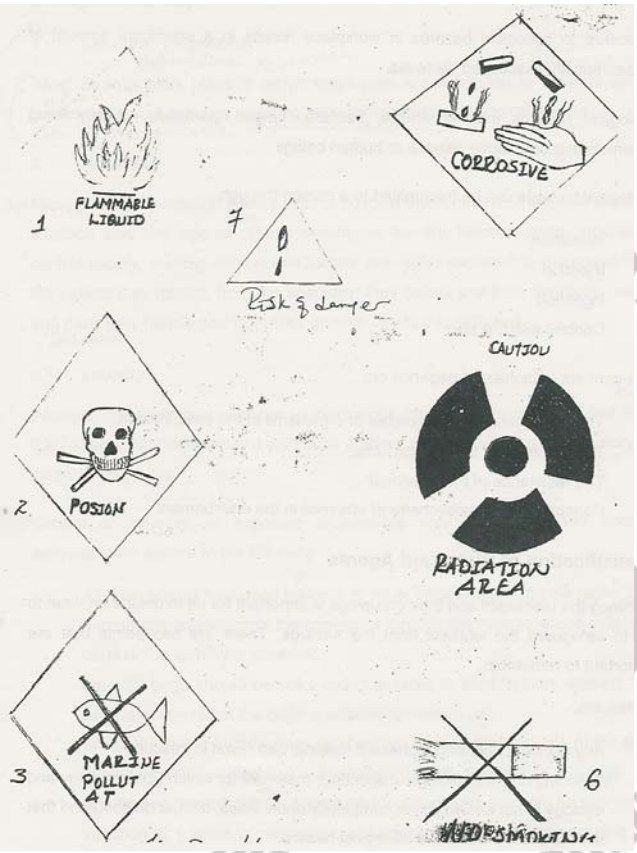

Fig 4. Hazard warning signs and symbols

Source: Barbara A. Plog, Fundamentals of Industrial hygiene, 4th. Edition, 1996

3.4 Biological Hazards

Knowing the biohazards and their classification based on severity of exposure problem is very important. It has to be understood that:

1. Any involvement with biohazards material may end up with infection.
2. When dealing with biological agents of which its etiology is not known it must be assured that it is it is a bio-hazard.

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 resistance of the individual
d. Concomitant physical/chemical stresses in the environment.

Classification of Biohazard Agents

Knowing the biohazard and their groupings is important for us 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

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, and blood, pipettes, laboratory specimens etc.

1. Laboratory Research

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. Hospitals

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.

2.1 Laundry

Workers in laundry are exposed to discharges from patients by virtue that they are constantly in 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 hazardous.

- 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.

2.2 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 all general cleaning activities.
- Widespread use of disposable materials, especially those used in 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.

2.3 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 dirty instruments or if the skin has a lesion that comes into contact with contaminated instruments.

2.4 Health care staff

The possibility of exposure to infection of health care professionals that have direct contact with patients is always present. The health

care worker can spread infection from:

- 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

To avoid such contamination health care workers should:

- Dispose of contaminated equipment properly so that no health hazard is exposed to infect others.
- Hands 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
- Isolation gowns, masks and caps must be worn whenever necessary and removed before entering clean areas such as rest areas and lunchrooms.

2.5 Dietary

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

Staphylococcus infection or food poisoning is produced by an enterotoxin that develops as the organism grows in the food product.

Primary prevention against infection or contamination of the food include:

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

- Adequate cooking of foods.

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

1. Inadequate sanitation, disinfect ion 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 four 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)
- Disease transmissible to human from the environment (animals being the source of environmental contamination)

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.

Health hazards associated with tannery

1. Hook worm and Ascaris infection
2. Sallmonolosis.

3. Malaria and onchocerciasis.
4. Schistosoma and anthrax
5. Hydrated cysts
6. Tetanus and infections of gangrene.

There are about 48 types of disease divided into three categorties.

Diseases with definite risk	Disease with quantifiable risk	Doubtful risk
Anthrax	Salmonellosis	Cowpox
Rabies	Plague	Taeneasis
Tetanus	TB	Trichniasis
Tularemia		Giardiasis

Health hazard Associated with Poultry Farming

Salmonelosis and scabies are the major health problem

Biohazard Control Program

1. Employee health.

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

2. Laboratory safety and health.

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

3. Biological safety cabinet

- To 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.

3.5 Ergonomic Hazards

The term ergonomics began to be used by a group of physical, biological, and psychological scientists and engineers to describe interdisciplinary activities that were designed to solve problems created by wartime technology. The term is derived from the Greek roots ERGON, which is related to work and strength, the NOMOS, indicating law or rule. It also means Human engineering or ”Fitting the job to the worker.”

The study of human characteristics for the appropriate design of scientific principles, method and data drawn from a variety of disciplines to the development of engineering systems in which people play a significant role are:

a. Human capabilities,
b. Human limitations,
c. Human motivations, and
d. Human desires

Ergonomics is the application of human biological science in conjunction with the engineering science in order to achieve optimum mutual adjustment of man and his work. It includes considerations of the total physiological demands of the job upon the worker even beyond productivity, health and safety

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 on man 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 well-being. To ensure a continuous high level performance work system must be tailored to human capacities and limitations measured by anthropometry and biomechanics.

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 bio-mechanics 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

1. Location of object to be lifted
2. Size of object to be lifted
3. Height from which and to which the object is to be lifted
4. Frequency of lift
5. Weight of object
6. Working position

Human Variable

1. Sex of worker
2. Age of worker
3. Training of worker
4. Physical fitness of worker
5. Body dimension of worker

Environmental variable

1. Extremes of temperature (hot/cold)
2. Humidity
3. 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 per minute while if it was extremely heavy work energy requirement is 15 Kcal. Min. and heart beat is 160/minute.

Workstation design

Workstation means the immediate area where the person working is performing his/her duties. The goal of designing a workstation is to promote ease and efficiency of the person working. Productivity will suffer if the operator is uncomfortable and suffering or if the workstation is awkwardly designed.

Work place design

Workplace is the establishment or deportment where the person or

worker is performing his/her duties. The most basic requirement for a work place is that it must accommodate the person working in it. Specifically this means that:

1. The work space for the hands should be between hip and chest height in front of the body
2. Lower location are preferred for heavy manual work, and
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, 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.

3.6 Psychosocial hazards

The term " stress" means the strain imposed on the worker by psychosocial influences associated with urbanization and works, which cause stress, which may affect health, well being, and productivity.

Within the work environment itself, 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 start to work in an industry. In his rural life he used to work at his 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.

4. Questions and Exercises

1. Select ten occupations common to your community. List the potential and real occupational risks associated with each type of employment.
2. What are the common health hazards of organic solvents?
3. Explain the reasons why the magnitude of occupational health hazards is increasing in health care industries (hospitals, health centers, laboratory etc).
4. What are the two main health effects of Noise?
5. How does the occupational environment of the worker affect the health of his or her families and the general population?
6. What are the criteria to state that substances are hazardous or dangerous?
7. What are the advantages of hazard warning symbols or signs?
8. Give two examples each for task, human and environmental variables

CHAPTER THREE

Evaluation of Occupational Health Safety and Hygiene Hazards

1. Learning objectives

At the end of this chapter, the student will be able to:

1. Define the objectives of hazard evaluation in workplace.
2. Explain the methods of dust measurement
3. Evaluate occupational exposure to noise
4. Explain the strategies of dust control.
5. Discuss the differences between Grab sampling VS Integrated sampling and personal sampling VS general sampling

2. Introduction

The previous chapters briefly traced the concepts of occupational health safety and hygiene. Also the type of hazards in the workplace, how they happen and their preventive measures were discussed. Following this it will be logical to discuss how we can actually evaluate the hazards in the work place. In this we will discuss instrumentation, and scientific or non scientific methods of evaluating the nature and extent of some health problems arising in occupational setting

The recognition and subsequent identification of the specific contaminants (dust, fume, gas, vapor, mist, microorganisms, and sound pressure level etc) is the first stage in the sequence. A number of spot check devices are used such as detector stain tubes for gases, or in the case of noise, a sound pressure meter.

Once the contaminants have been identified, it is necessary to measure the extent of the contamination. Evaluation is an important part of the procedure for measurement. Measured level of contamination must be compared with existing hygiene standards (always assuming there is such a standard applicable to the material in question), such as exposure limits, control limits and recommended

limits. In addition, the duration and frequency of exposure to the contaminants must be taken into account. Following a comprehensive evaluation, a decision must be made as to the actual degree of risk to workers involved. This degree of risk will determine the control strategy to be applied.

3. Evaluation of occupational Environment

The basic principles to evaluate occupational health safety and hygiene hazards, and the philosophical basis for establishing safe levels of exposure to chemical, physical and biological agents is based on evaluation of occupational environment.

Evaluation can be defined as the decision making process that results in an opinion as to the degree of risk arising from exposure to chemical, physical, biological, or other agents. It also involves making a judgment of the magnitude of these agents and determines the levels of contaminants arising from a process or work operation and the effectiveness of any control measures used.

Evaluation Methods

Area or environmental sampling Vs personal sampling

Environmental sampling includes sampling for gases, vapors, aerosol concentrations, noise, temperature etc. Which are found on the worker or the general work area or environment.

Area or general room air samplings are taken at fixed locations in the work place. This type of sampling does not provide a good estimate of worker exposure. For this reason it is used mainly to pinpoint high exposure areas, indicate flammable or explosive concentrations, or determine if an area should be isolated or restricted to prevent employees from entering a highly contaminated area.

Personal sampling

The objective of personal sampling is to see the extent of exposure of the person working on a particular contaminant while he/she is working at a location or work place. For example, if the worker is working in a garage where cars are painted the area as a whole is sampled to see how much lead which is present in all car paints, is on the air but with personal sampling one can determine how much are inhaled by the person performing the work or those who are working near by. In short it is the preferred method of evaluating workers exposure to air contaminants.

Grab Sampling Vs integrated Sampling

Air sampling can be conducted for long or short periods depending upon what type of information is needed.

Instantaneous or grab Sampling is the collection of an air sample over a short period whereas longer period of sampling is called integrated sampling.

1. Grab samples represent the environmental concentration at a particular point in time. It is ideal for following cyclic process and for determining air- borne concentration of brief duration but it is seldom used to estimate eight-hour average concentration.
2. In integrated sampling, a known volume of air is passed through a collection media to remove the contaminant from the sampled air stream. It is the preferred method of determining time weighted averages exposure.

a. Dust evaluation

To evaluate dust exposure, it is first necessary to determine the composition of dust that are suspended in the air where workers breathe. Operation that involves the crushing, grinding, or polishing of minerals or mineral mixtures frequently do not produce airborne dusts that have the same size composition.

When air samples are collected in the immediate vicinity of dust

producing operation, larger particles that have not yet had time to settle from the air may be collected. If a larger number of these particles appear in the dust sample, the effect of their presence may have to be evaluated separately.

To evaluate either the relative hazard to health posed by dusts or effectiveness of dust control measures, one must have a method of determining the extent of the dust problem. Ideally the method employed should be as closely related to the health hazard as possible. The basic methods are briefly discussed below.

1. Count Procedure

The concern of industrial hygienists has been to measure the fraction of dust that can cause pneumoconiosis. Since it has been recognized that only dust particle smaller than approximately 10 micrometer are deposited and retained in the lung method were sought to measure the concentration of these tiny particles. Microscopic counting of dust collected has long been used for this purpose.

2. " Total " Mass Concentration Method

The simplest method of measuring dust concentration is to determine the total weight of dust collected in a given volume of air. The " total" mass, however, is determined to a considerable extent by the large dust particle, which can not penetrate to the pulmonary space and cause adverse health effect. Thus the total dust concentration by weight is not a reliable index of "respirable" dust concentration. This is because in this method of measurement the proportion of dust that is small enough to penetrate into the pulmonary space (respirable dust 2.5-micrometer) is extremely variable ranging from 5 percent to 60 percent.

3. Respirable Mass Size Selection Measurement (Personal sampling)

When measuring respirable dust the method now commonly used is personal or breathing zone respirable mass sampling? Dust collection devices now available for this method of sampling also provide a means for a size frequency analysis of the collected dust.

Respirable mass samples are preferably taken over a full 8 hour shift. However, multiple, shorter period samples (over a 2-4 hour period) may be collected during an individual full shift period.

In general, any dust particle producing activity will have respirable dust. For example road construction, cotton ginning, stone crushing and milling site, farm sites etc all produce same amount of dust. By practice 30-40% of dust are respirable. Even if we cannot measure the particle size using instrument, we can tell by the mass produced in a certain work site that the worker is exposed to respirable dust particle.

Air evaluation

Air sampling instruments

The sampling instruments are geared to the type of air contaminants that occur in the work place that will depend upon the new materials used and the processes employed

Air contamination can be divided into two broad groups depending upon physical characteristics.

- Gases and vapors
- Particulate

Type of Air Sampling

The type of air sampling to be used depends upon a number of factors.

- The type of sampling
- The equipment available

- The environmental condition
- The nature of the toxic contaminants

b. Noise Evaluation

The purposes of a detailed noise survey are:

1. To obtain specific information on the noise levels existing at each employee Workstation
2. To develop guidelines for establishing engineering and/or administrative Controls.
3. To define areas where hearing protection will be required.
4. To determine those work areas where audiometric testing of employees is desirable and/or required.

Surveys will help us to determine:

- Whether noise problems exist or not;
- How noisy is created in each work place or station,
- What equipment or process is producing the noise,
- Which employees are exposed to the noise often,
- Duration of exposure to the noise, etc.

Therefore, for evaluation purposes noise measurement is conducted using such strategy such as:

1. Measuring noise levels using area measurement methods
2. Work station measurement

Sound Survey

Sound measurement falls into two broad categories.

1. Source measurement
2. Ambient-noise measurement

Source measurement involves the collection of acoustical data for the purpose of determining the characteristics of noise radiated by a source.

Ambient noise measurement ranges from studying a single sound

level to making a detailed analysis showing hundreds of components of complex variations.

Because of the fluctuating nature of many industrial noise levels, it would not be accurate or meaningful to use a single sound level meter reading. For this reason a preliminary and a detailed noise survey has to be conducted in the industry.

There are wide assortments of equipment available for noise Measurement. Some of these instruments are:

1. Sound Survey meter / Sound level meter/
2. Octave band analyzers
3. Narrow band analyzers
4. Tape and graphic level recorders
5. Impact sound level meters
6. Dosimeter

For most noise problems encountered in industries, the sound level meter and octave band analyzer, and if available noise dosimeter provide ample information.

Sound level Meter/Sound survey meter/

This is one of the basic instruments used to measure sound pressure variations in air. This instrument contains a microphone, an amplifier with a calibrated attenuator, a set of frequency response networks, and an indicating meter. It is an electronic voltmeter that measures the electrical signal emitted from a microphone attached to the instrument.

Exposure duration at workstation where the regular noise levels varies above 85 dBA.

4. Questions and Exercises

1. What variables would you use to determine the level of safety in a given Occupational settings?

2. Take a walk around your college or university. Assess the safety of your campus. Look at traffic, lighting, accessibility, indoor air, obstruction, classroom conditions, sanitation, and related factors. Make suggestions to improve the safety of campus and submit the suggestions to the responsible body in your campus.
3. Explain the difference between grab sampling and integrated sampling?
4. How can you evaluate the level of noise in occupational setting?
5. Mention the occupational exposure to noise in your college or university ”Community”.
6. Evaluate your classroom in terms of biological hazard, noise, dust, ergonomic and other physical hazards.

CHAPTER FOUR

Small-scale Enterprises and Informal Sectors in Ethiopia

1. Learning objectives

At the end of this chapter, the student will be able to:-

1. Define small-scale enterprises and informal sectors
2. Describe the common problems of SSE and IS
3. Discuss the general actions to be taken on SSE and IS

2. Introduction

Workers in developing countries like Ethiopia are employed in small industries or agricultural settings. These workers are often uneducated or poorly educated, unskilled and inexperienced with a tool they are using or the hazards associated with work process and their employers often have limited financial resources.

A study conducted in the urban and rural informal sectors in Zimbabwe and South Africa revealed that the health problems reported in the informal sectors are generally the same as the formal sectors.

The conditions and problems observed in some informal sectors of Ethiopia are not far from the facts described above.

1. Common features of Small Scale Enterprises and informal sectors

- There is no clear boundary between the working and the living environment
- Unsafe building or work places which are often associated with

poor working designs, which may have inadequate light and ventilation

- Unsatisfactory hygiene and sanitation facilities
- Cramped and ergonomically inadequate work spaces and safety
- The work processes involve often low technology and budget which are operated by employees with limited training and education
- Protective clothing such as respirators, gloves, apron, boot and other safety equipment are seldom available or used
- Inappropriate working hand tools and equipment
- Poor access to information, lack of knowledge about hazards, their effects and control measures, low degree of mechanization
- Majority of them have no permit.
- Employment and insurance polices are nil.
- Management of health is absolutely unknown.
- Vocation and salary is absolutely unknown.
- Low capital resources

3. Types of small scale enterprises and informal sectors

Examples of some small-scale enterprises and informal sectors where the inspection, education and evaluation of the Sanitarian is needed are. However, some of these could also be considered large enterprises in some areas.

1. Tannery (SSE)
2. Pottery (IS)
3. Wickery (wickerwork) (IS)
4. Bakery (SSE)
5. Weaver (IS)
6. Oil-seed crushers (SSE)
7. Blocket, pipe, tile makers (IS)
8. Stone crushers (IS)
9. Brick-makers (IS)
10. Carpentry (IS)
11. Welders (IS)
12. Miller (IS)

13. Garage (SSE)
14. Glass cutters (IS)
15. Butchers (IS)
16. Blacksmith (IS)
17. Charcoal producers ((IS)
18. Carpet makers (IS)
19. Dairy farm (IS)
20. Chicken farm (IS)
21. Soap makers (IS)
22. Bee farm (honey) (SSE)
23. Animal fattening farm (SSE)
24. Mining (SSE)
25. Foundries (SSE)
26. Grinding (IS)
27. Boiling (IS)
28. Painting and paint making (IS)
29. Dying and dye products (SSE)
30. Quarrying (IS)
31 Cutting (IS)
32. Burning (IS)
33. Cleaning (IS)

Health hazards associated with pottery

a. Clay soil digging

- Falling
- Mechanical accidents
- Land sliding (collapse)
- Diseases from soil such as Tetanus, URTI, Pneumoconiosis, Silicosis, Asbestosis
- Poisoning - Arsenic, lead, silica.

b. Clay preparation

- The raw clay prepared by burning as the result there may be

- Air pollution
- Heat
- Dust
- Fume.

c. Clay forming (shaping)

Since they do have direct contact with water

- Water related disease
- Food borne diseases

d. Clay drying

- Heat
- Burn
- Cram
- Rash (excessive heat)

e. Firing and glazing

- Air pollution
- Accidents (falling)
- Psychological problem.
- Poisoning
- Lack of transportation for market is the cause for fatigue and other health problems.
- Low selling price.
- Deforestation

4. General action on small-scale enterprises and informal sectors.

1. Survey must be made on
   - Types
   - Numbers
   - Potentiality of resources in terms of money
   - Problem

- Economical
- Managerial

2. What types of
   - Organization
   - Establishment
   - Cooperation
   - Communication
   - Transportation
3. On job and off job training
4. Provision of health facilities.
   - Basic environmental sanitation.
   - Hospitals, Health center, clinics /health post/
   - Nutritional counseling.
5. General and Health education on
   - Scientific facts
   - Technologies
   - Production and marketing.
   - Salary and transaction
   - Employment

5. Questions and Exercises

1. What are the main differences between small-scale enterprises and informal sectors?
2. What are problems of SSE and IS?
3. What are actions to be taken to improve the status of SSE and is in Ethiopia?
4. Mention the health hazards associated with pottery and tannery?
5. Informal sectors in Ethiopia at present time

   a/ Are well organized.

b/ Are not source of health problems

c/ Are unnecessary to the community.

d/ None of the above

6. Prepare a checklist and conduct survey on small scale enterprise and informal and sectors found in your community report your findings to concerned body in your locality.

CHAPTER FIVE

Prevention and Control of Occupational Health safety and Hygiene Hazards

1. Learning objectives

At the end of this chapter, the student will be able to

1. Describe the objectives behind prevention and control of occupational health safety and hygiene hazard.
2. Explain the prevention and control methods of Occupational hygiene.
3. List down the importance of personal protective equipment
4. Discuss the difference between local exhaust ventilation and general ventilation
5. Explain the reasons for miss utilization for personal protective equipment.

2. Introduction

The classic occupational hygiene model of controlling a hazard indicates that the ideal situation is to prevent exposures altogether. This is known as control at the source and utilizes substitution or enclosure of the hazard, as well as other means. If this cannot be achieved, exposure should be reduced along the path, through ventilation, protective barriers, or related measures. Only as a last resort, 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.

Once you recognize a hazard, then you can determine which measure will correct the problem most effectively. Generally, there are five major categories of control measures: elimination, substitution, engineering controls, administrative controls and personal protective equipment. Eliminating a hazard means

removing it completely; substitution is replacing one hazardous agent or work process with a less dangerous one. 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 is an example of an administrative control (for example, job rotation); and personal protective equipment (PPE) includes ear and eye protection, respirators, and protective clothing.

Remember it is always better to control the hazards as close to the source as possible. Using personal protection is the least acceptable and least effective of all control measures.

3. Prevention and control Methods of occupational health safety and hygiene hazards

1. Elimination

Elimination of a specific hazard or hazardous work process, or preventing it from entering the work place, is the most effective method of control.

Eliminate hazard at the developmental stage

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 export to developing countries, causing workers to pay the price with accident, hearing loss from noise, etc.

2. 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:

- Less hazardous instead of toxic ones.
- Detergent plus water cleaning solutions instead of organic solvents
- Freon instead of methyl bromide chloride as a refrigerant
- Leadless glazes in the ceramics industry
- Leadless pigments in paints
- Synthetic grinding wheels (such as aluminum oxide, silicon carboide) instead of sandstone wheels.

3. Engineering controls

There are number of common control measures which are called engineering control. This includes enclosure, isolation and ventilation.

3.1 Enclosure

If a hazardous substance or work process cannot be eliminated or substituted, then enclosing it so workers are not exposed to 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 workers coming into contact with dangerous parts of machines. Workers should receive training on how to use guarded machine safely.

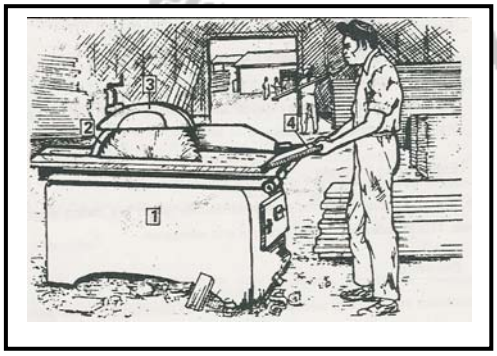

Fig 5. Guarded circular saw

Source: Deglaville etal. Occupational Health, a manual for health workers in developing countries.

3.2 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 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.

3.3 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.

Local Exhaust ventilation

- General or dilution Ventilation

1. 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 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.

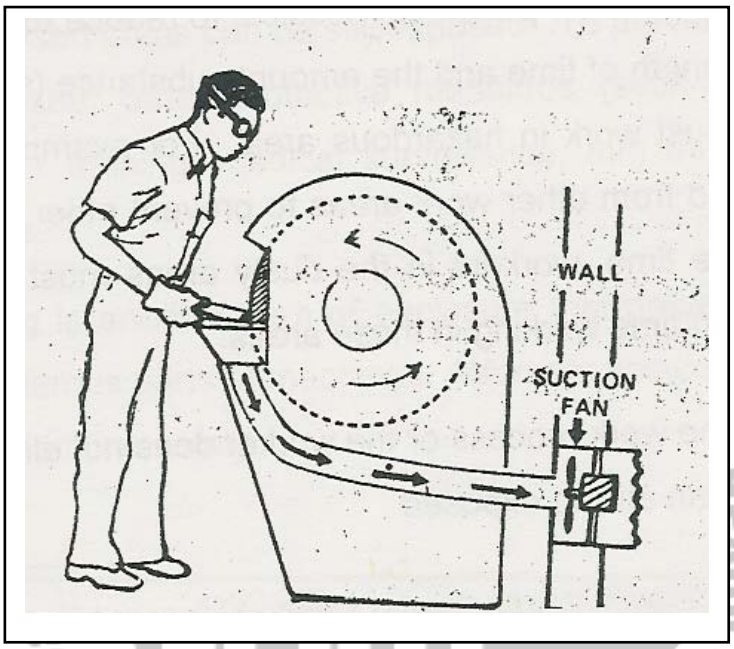

Fig.6. Local exhaust ventilation

Source: Deglaville etal. Occupational Health, a manual for health workers in developing countries

2. 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.

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 hazardous. Some examples of administrative controls include:

- 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
- Moving a hazardous work process so that few people will be exposed
- Changing a work process to a shift when fewer people are working

An example of administrative controls being used together with engineering controls and personal protective equipment is: a four-hour 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:

1. Safety goggles

Fig.7. Safety goggles protects the eyes

Source: Deglaville etal. Occupational Health, a manual for health workers in developing countries

2. Face shield and gloves

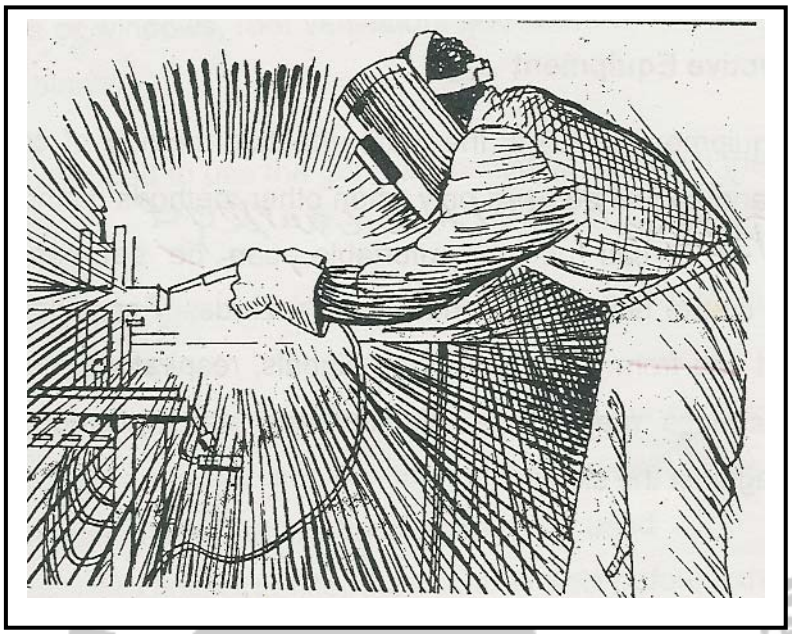

Fig. 8.protective face shield and gloves

Source: Deglaville etal. Occupational Health, a manual for health workers in developing countries

3. Helmet

Fig.9. A safety helmets protects the head from possible injury.

Source: Deglaville etal. Occupational Health, a manual for health workers in developing countries

2. Dust masks
3. Gloves
4. Protective suits
5. Safety shoes

6. Plant Sanitation

Workers health, physical and psychological development 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.

- The provision of safe potable and adequate water supply.
- Proper collection and disposal of liquid waste.
- 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.
- Maintaining good ventilation and proper lighting systems.

6.1 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:

- It may be used as raw material in the production process.
- Used for cooling purposes in the machines
- Used for cleaning and washing of equipment
- Used by employees to keep their personal hygiene

- Serve as a means for waste disposal in water carrying systems
- 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.

6.2 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:-

- 1 wash basin for every 15 workers for clean work
- 1 wash basin for every 10 workers doing dirty work
- 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.

- All showers should be separated for male and female workers to guarantee privacy
- Emergency facilities must be available where there is a danger of skin contamination by dangerous or poisonous substances
- Emergency shower or eye wash facility
- Accessory materials

6.3 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.

6.4 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.

7. 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 cuts down the amount of spoiled work and therefore it is economically profitable.

8. 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.

9. Emergency response training and education

- First aid and fire drilling

10. Questions and Exercises

1. What are the principles and control methods of occupational health safety and hygiene problems?
2. What does health promotion mean in the workplace and how is responsible to deliver it?
3. What are the causes of miss utilization of personal protective devices among the workforce?
4. Discuss on the roles of safety rules in a certain occupational settings.

GLOSSARY

1. **Acute**. Health effects that show up a short length of time after exposure.
2. **Administrative control.** Methods of controlling employee exposures by job rotation, work assignment or training in specific work practices designed to reduce exposure.
3. **Aerosols.** Liquid droplets or solid particles dispersed in air that is fine enough particle size (0.01-100mm) to remain so disposed for a period of time.
4. **Asbestos.** A hydrated magnesium silicate in fibrous form.
5. **Asbestosis.** A disease of the lungs caused by inhalation of fine airborne asbestos fibres.
6. **Asphyxia.** Suffocation from lack of oxygen.
7. **Asphyxiate**. A gas whose primary or most acute health effect is asphyxiation.
8. **Biohazard.** organisms or products of organisms that present a risk to humans.
9. **Chronic.** Persistent, prolonged, repeated.
10. **NContact dermatitis**. Dermatitis caused by contact with a substance gaseous liquid or solid.
11. **d BA.** Sound level in decibels read on A scale of a sound level meter.
12. **Disinfectant** An agent that frees from infection by willing the vegetable cells of microorganisms.
13. **Engineering controls.** methods of controlling employee exposures by modifying the source or reducing the quality of contaminants released into the work environment.
14. **Entrotoxin.** A toxin specific to cells of the intestine gives rise to symptoms of food poisonous.
15. **EPA**. Environmental protection agency.
16. **Epidemology.** The study of disease in human populations.

17. **Exhaust ventilation.** The removal of air usually by mechanical means from any space
18. **Fume.** air source particulate formed by the condensation of solid particles from the gaseous safe
19. **General ventilation.** system of ventilation consisting of either natural or mechanically induced fresh air movements to mix with and dilute contaminants in the workroom air. This is not the recommended type of ventilation to control contaminants that are toxic.
20. **Grab sample.** A sample taken within a very short time period to determine the consistence at a specific time.
21. **Hazardous material**. any substance or compound that has the capability of producing advance effects on the health and safety of humans.
22. **Heat cramps.** painful muscle spasm as a result of exposure to excess heat.
23. **Heat exhaustion.** A condition usually caused by loss of body water because of exposure to excess heat.
24. **Heat rash**. itchy rash caused by sweating and in adequate hygiene practice.
25. **Hertz**. the frequency measured in cycles per second.
26. **Hood.** Enclosure, part of a local exhaust system.
27. **Ionisation radiation**. Electrically charge & or neutral practices.
28. **Local exhaust ventilation**. A ventilation system that captures and removes the contaminants at the point at which they are seeing produced severe they escape in to the workroom air.
29. **Mist**. suspended liquid droplets generated by condensation from the gaseous to the liquid state or by breaking up a liquid in to a dispersed state.
30. **No ionising radiation. Electromagnetic** radiation causes ionisation.
31. **OSHA.** U.S occupational safety and health administration.

32. **Threshold Limit value.** is concentration by volume in air under which it is believed that nearly all workers may be repeatedly exposed day after day without adverse effect.
33. **Permissible Exposure Limit.** is amount permitted for a specific period within a working day
34 **Primary prevention**. This is preventing healthy people from becoming sick.
35 **Secondary prevention.** This involves detecting people who already have the disease as early as possible in order to cure the patient and prevent chronic disease and disability.
36 **Tertiary prevention.i**t is prevention of more disability and health
37 **Abatement**. Removal or discontinuance of a nuisance.
38. **Accident.** An occurrence in a sequence of events that produces unintentional injury, death or property damage.
39 **Ambient.** Surrounding condition of environment, usually referring to air quality or noise.
40. **CDC** - Centre for disease control, a part of the united states public Health Service.
41 **Health.** A state of complete physical, mental and social well - being, not merely the absence of disease (WHO).
42. **Health promotion.** Any combination of educational, organizational, economic, and environmental supports for conditions of living and behaviour of individuals, groups, or communities conductive to health.
43. **Occupational safety**. Injury control in specific work site.
44. **Synergistic**. When two or more factors combine to produce an effect that is greater than the sum of their individual effects.
45. **Industrial hygienist.** are occupational health professionals who are concerned primary with the control of environmental stress or occupational health hazards that arise as a result of or during the course of work.

46. **Personal protective equipment (PPE**). devices worn by the worker to protect against hazards in the environment.
47. **Pneumoconiosis.** dusty lungs a result of the continued inhalation of various kinds of dust or other particles.
48. **Silicosis.** A disease of lungs caused by the inhalation of silica dust
49. **Smog** Irritating hat resulting from the sun's effect on certain pollutants in the air, notably automobile and industrial exhaust
50. **Solvent.** A substance that dissolves another substance usually refers to organic solvents.
51. **Zoonoses.** A disease of vertebrate animals that can be transmit to man and other animals.

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Annex

1. Check list for investigation of occupational health & safety conditions in workplaces

1. Name of industry factory _____ Year, est. _____
2. Address: Kefitegna _____ Kebele _____ House number _____
3. Name of owner (Manage) _____ Telephone _____
4. Main product _____ by product _____

I. General Information

1. Location
   a. Industrial _____ b. Residential _____
   c. Near to any water body _____
   d. Other, please specify _____
2. Construction
   a. Wood & mud plaster _____ b. Wood, plaster _____
   c. Old but well maintained _____ d. Brick cement. _____
   e. Other, please specify _____
   _____
3. Condition of building structure
   a. Very old _____ b. Old _____ c. New _____
   d. Old but well maintained _____
4. Accident & injury registration
   a. Yes _____ b. No _____

   If yes type of accident

   1. _____
   2. _____
   3. _____

5. Number of total accidents _____

II Potential health & safety hazard

a. Physical hazard

1. Heat
   a. Excessive _____ b. Moderately hot _____
   c. Comfortable _____

2. Noise
   a. Excessive _____ b. Moderate _____
   c. No noise _____

3. Air borne contaminate

Observed (parameters) High Moderate Low No source

   a. Dust _____
   b. Smoke _____

4. Lighting

a. Type

a) artificial _____ b) natural ____ c) both _____

5. Ventilation

a) Natural ___ b) Artificial _____ c) Both _____
d) Excess ventilation (draft)
e) Adequate & comfortable
f) Volume of air per person. _____ (1x bx h/No. of persons)

6. Ventilation

a) Unguarded machine ____ b) exposed wire (electric) _____
b) Crowded with materials & people _____
c) Surface area per worker _____ 1x b of floor/no. of worker

b. Chemical Hazards

1. Poisoning or irritant gas or chemical

a) Lead fumes ____ b) pesticides or insecticides ___
c) Naphta ____ d) Benzine ____ e) Terpentine ____
f) Vernish ____ g) Dying & coloring _____ h) Glues
i) Rodenticide _____

2. Type of chemical used

1. _____ 2._____ 3. _____
4. _____ 5. _____

3. Actual cumulative amount of chemical used:

a) Per day _____ b) per month _____ c) Per year ____

4. Extent of exposure to chemicals

a) Heavy _____ b) Moderate ____ c) Light _____
d) Protected _____ e) No chemicals involved.

III. Accident control methods or Mechanisms

1. Personal protective equipment

a) Far muffs ___ b) Respirators __ c) Goggles _____
d) Gloves ___ e) Boots _____ f) Aprons
g) Other, Please specify _____
_____

2. Exhaust fan

a) Yes _____ b) No _____

If yes

a) Total number_____ b)Functioning _____

c) Not functioning_____d) not used _____

3. Potential for fire

a) Highly potential ___ b) Moderately potential _____

c) No risk of fire _____

If there is the poterntial for fire do they have fire fighting arrangement?

a) Yes b) No

If yes:

a) Chemical type (CO_2) _____ b) pond water with pump _____

c) Verbal education _____ d) No materials or programs. ____

e) Other, please specify _____

VI. Health service

Particulars	Yes	Number			Total
		Nurse	H.A	Other	
a. Operational clinic with (Nurse. H.A)					
b. First aid with trained staff					
c. First aid with not trained staff					
d. No clinic					
e. No first aid					
Other please specify					

V. Sanitary Facilities & conditions

Parameters	Yes	No	Adequate	Clean	Safe
a) Water supply b) Toilet Facility					
c) Hand washing facility d) Shower					
e) Clock room					

VI. Insect vectors and rodents observed

a) rats _____ b) Flies ____ c) Fleas ____ d) Chigger flee ____

e) Cockroaches _____

VII Refuse collection

a) Tin bin with cover ___ b) bamboo basket with cover _____

c) Open disposal in the yard _____ d) Other, please specify

_____

_____

VIII. Refuse disposal

a) Municipal collection & disposal _____ b) Recycled _____

c) Sold _____ for other use d) Burn in the yard _____

IX . Lunch room

a) Excellent sanitary standard _____ b) Very good San. Stand. ____

c) Good San. Stand. D) Poor San. Sta. _____

e) No need to have lunch room

f) f) No lunch room but workersbring food to the work site _____

X. General house keeping

Particulars	Yes	No
a) Dusty floor liters every there		
b) Unclean walls & ceilings (spider/webs dirt etc.)		
c) Decomposed waste matter on floors, under benches etc.		
d) Clogged drain		
e) Unorganized raw materials on floor		
f) proper storage of raw materials		

XI Plant sanitation ratio

a) Excellent b) Very good c) Good d) poor

Name of inspector _____ Signature_____

Date _____

2. Personal Monitoring Equipment

- Fold-down earmuff
- Minor's lamp
- Lamp cord
- Hard hat
- Safety glasses
- Thermoluminescent (TLD)badge
- Gloves
- Reflective stripes
- Gamma meter
- Safety belt
- Radio
- Lamp battery
- Radon dust pump

- Coveralls
- Rubber steel-toed boots

3. Checklist for personal protective Equipment Programs

- Correct equipment
- Through training program
- Fit test
- Regular equipment maintenance
- Secure and clean place of storage for each individual's set of equipment